FY 2020 Competition Information Sheet

Program Names

Climate Variability and Predictability (CVP)
Climate Observations and Monitoring (COM)
Modeling, Analysis, Predictions, and Projections (MAPP)
National Integrated Drought Information System (NIDIS)
Assessments (AP)

Focus for FY20

Explaining Climate Extreme Events: Developing a Rapid Assessment Capability and Understanding the Causes and Mechanisms of Extreme Events

Funding for FY20

Pending the availability of funds in FY 2020, it is anticipated that $750,000 will be available to fund 4 type 1 proposals, which should target a funding level of $150,000-$200,000 per year for three years.

It is anticipated that one type 2 proposal will be funded at a level of up to $1,000,000 per year for three years with $400,000 available for a fourth year. The bulk of the funds for type 2 proposals should be utilized to support activities based at NOAA laboratories, centers, and Cooperative Institutes. Proposing teams for type 2 projects should consider a declining funding profile as part of a demonstration that the capability could be maintained as part of or leveraging existing activities. Some funds may be utilized for collaborations with the non-NOAA community. Additional resources outside of the above total may be available to the team to help support proposed community workshop logistics and planning.

Competition Information

Title: Explaining Climate Extreme Events: Developing a Rapid Assessment Capability and Understanding the Causes and Mechanisms of Extreme Events

Extreme events in the climate system have a profound effect on the safety of the American public and the security and productivity of the American economy. Together, these events create an annual cost burden of hundreds of billions of dollars for the U.S. economy. Efforts to better predict, project, and prepare for these events are foundationally supported by improved understanding, observation, and modeling of their causes. To that end, proposals are solicited in FY20 to explore and develop the science of explaining climate extreme events, and to develop and test an experimental capability to rapidly assess and explain extreme events.

NOAA's Billion-Dollar Disasters database[1] documents the occurrence of events that cause over a billion inflation-adjusted dollars of acute damage. Since 1980, 246 events with total costs exceeding $1.6 trillion

[1] https://www.ncdc.noaa.gov/billions/

have been documented. This database captures the highest-magnitude impacts of extreme events on people's lives and the American economy, but there are many other additional smaller events that cause significant aggregate effects at National or regional scales.

NOAA works to monitor, predict, and disseminate information about events such as these to save lives, diminish impacts, and build resilience. Undergirding these efforts are research to improve models and observations, develop understanding, and provide actionable information so as to better simulate, describe, and characterize extreme events and their causes, and to inform the public of geospatial risks.

The ability to expertly understand and characterize the contribution of various factors to an extreme event is a rapidly developing field which allows exploration of the causes of various events in the climate system, and the ability to separate various mechanistic forcings that lead to extreme events. This emerging capability harvests decades of model development, observational records, and growing understanding of the phenomenology of extreme events. The knowledge gained from these attribution studies undergirds discussions in the National Climate Assessment, particularly regarding the nature of extreme events and their causes. A 2016 National Academy of Sciences report on extreme event attribution[2] noted the importance of science to explain the causes of events to:

> "...satisfy the public's desire to know but also [to] provide valuable information about the future risks of such events to emergency managers, regional planners, and policy makers at all levels of government. A solid understanding of extreme weather event attribution in the context of a changing climate can help provide insight into and confidence in the many risk calculations that underpin much of society's building codes; land, water, health, and food management; insurance; transportation networks; and many additional aspects of daily life."

As an emerging area of research, this unifies many relevant thrusts across NOAA and the Climate Program Office (CPO). NOAA has deep expertise and a rich set of capabilities in the modeling and observational space, which has been leveraged in the past to explain extreme events, e.g., in the case of explanatory studies led or contributed to by NOAA of droughts[3,4], floods[5,6], and other events. Harnessing modeling and observations to explain extreme events fits squarely into NOAA's mission to "...understand

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[2] National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington, DC: The National Academies Press. doi: 10.17226/21852 https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change

[3] https://www.drought.gov/drought/documents/causes-predictability-and-historical-context-2017-us-northern-great-plains-drought

[4] https://cpo.noaa.gov/Meet-the-Divisions/Earth-System-Science-and-Modeling/MAPP/MAPP-Task-Forces/Drought/Drought-Task-Force-I/Causes-and-Predictability-of-the-2011-2014-California-Drought

[5] https://wwa.colorado.edu/resources/front-range-floods/assessment.pdf

[6] https://www.noaa.gov/media-release/climate-change-increased-chances-of-record-rains-in-louisiana-by-at-least-40-percent

and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources."[7]

Current CPO and predecessor research programs have invested for decades in research to understand interactions between the climate system and extremes, dataset development to capture longer and fuller records of climate variability and change, evaluations of the ability of models to simulate extremes, and work to explain the linkage between extreme events and climate trends and variability. Building on this work, the development of a capability to explain the causes of and mechanisms driving extreme events involves a number of program-specific activities including the development and examination of long-term observational records; testing and applying models' ability to simulate low-frequency, high-impact events; improving understanding of the mechanisms that control and allow for predictability of extreme events in the ways those high- and low-frequency phenomena interact; assessment of climate; and improving communication of the risks and causes of extreme events to stakeholders and communities to build resilience. Moreover, this research area builds on the myriad modeling, observational, assessment, and product development and delivery activities across NOAA, and directly informs the National Climate Assessment.

In FY20, a number of CPO programs are collaborating to support research and development activities around the topic of explaining extreme events. Programs include:

- Climate Variability and Predictability (CVP)
- Climate Observations and Monitoring (COM)
- Modeling, Analysis, Predictions, and Projections (MAPP)[8]
- National Integrated Drought Information System (NIDIS)
- Assessments (AP)

Two types of research proposals are solicited under this effort. Proposed research for both types of proposals described below should focus on particular types of extreme events -- extreme heat or cold events, droughts, and/or marine extremes impacting the Nation's blue economy, and should focus on the United States and outlying territories. Evaluation of the skill or performance of prediction systems is beyond the scope of this competition.

Type 1 proposals submitted in response to this solicitation should focus on increasing our process-based understanding of the climate mechanisms that influence the extreme event types noted above with a focus on the influence of and interactions between low-frequency (e.g., interannual to multi-decadal) variability in the climate system and long-term trends, and how those interactions impact the ability to make scientifically-sound, quantitatively-based assessments of the factors that contribute to and cause extreme events. Projects may focus on historic case studies to undergird analysis of particular types of extreme events. Outcomes of the proposed research should be relevant to and fill knowledge gaps for the National Climate Assessment. Proposers should consider how their work will support, interact with, and contribute to the activities of the type 2 core team.

Type 2 proposals submitted in response to this solicitation should explore the research questions above as well as the development of a potential rapid event analysis and assessment capability, and should

[7] https://www.noaa.gov/about-our-agency

[8] Applicants may be interested in reviewing MAPP's FY20 drought and marine competitions for additional research opportunities related to the science of explaining extreme events.

focus on all, or a suitable subset of the types of extreme events listed earlier. Proposed work should focus on research questions regarding the appropriate approaches to rapid analysis and explanation of these extreme events including:

- the types of techniques to be applied including various conditional and unconditional modeling approaches; various observational approaches; artificial intelligence and neural network approaches;
    - exploring the limitations of approaches, e.g. ability of observational records and models to appropriately capture and characterize low-frequency high-impact events and the mechanisms that control those events, or the treatment of biases in model and observational datasets; applying multiple techniques to help characterize uncertainty;
- thresholds to trigger a study and timing of such a study, particularly for long-evolving extremes such as droughts;
- how to routinize methodologies, analysis, and product production in order to provide information with rapidity;
- design features specific to particular types of extremes but also potentially generalizable or extensible to other types of extreme events or broader questions about climate variability and trends (e.g., persistent features of North American climate such as the warming hole);
- identification of model and observational gaps that require focused research and development to better capture and describe extreme events and the mechanisms that control them;
- how to communicate results to maximize their interpretability across various stakeholder and user communities, particularly for decision needs, and integrating a strong treatment of uncertainty;
- how to include a process of performance assessment and iterative improvement in the rapid event analysis and assessment capability and what such a performance assessment element would entail.

Type 2 teams should:

- scope this activity in the context of NOAA's Technical Readiness Levels[9] roughly moving from RL 2 (applied research) to RL 7 (prototype system demonstration) over the course of the project. In particular, the team should consider how extreme events occurring during the project, particularly in the latter years, could be leveraged as real-time test cases to develop, test, and demonstrate the feasibility of a rapidly-produced study of an extreme event;
- engage with and leverage the capabilities of the Technical Support Unit (TSU) at the National Centers for Environmental Information, exploring how the developed capability can augment existing NOAA Assessment activities led by the TSU;
- consider how to engage or leverage ongoing activities with the Regional Integrated Sciences and Assessments (RISA) teams or other regional applied science capabilities supported by NOAA;
- target the prospective capability to be flexible and efficient from a staff and resources perspective, leveraging ongoing activities and capabilities as much as possible, and envisioning how a capability would be operable within existing activities, structures, and resources[10];
- integrate management and collaboration plans that will effectively and productively engage scientists and staff from across NOAA institutions with each other by including elements such as

[9] https://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-105B.html
[10] CPO funds competitive, limited-term research projects and will not support maintenance of a capability beyond the experimental phase. Thus, the proposal should discuss how a capability might be maintained as part of existing structures and/or without resources from competitive research programs.

co-designed and led community workshops, visiting scientist opportunities across NOAA institutions, regular team calls and/or meetings, or other elements that will encourage proximity and open collaboration across the research team;
- plan and prepare for a review of the project during the second half of the third year of the project period;
- propose a way to lead, entrain, and coordinate relevant type 1 projects funded as part of this solicitation to engage the broader community in this effort; and
- leverage lessons learned from the EUropean CLimate and weather Events: Interpretation and Attribution (EUCLEIA)[11] experiment and other international efforts.

Points of Contact:
Competition Manager - Dan Barrie (daniel.barrie@noaa.gov)
CVP Program - Sandy Lucas (sandy.lucas@noaa.gov)
COM Program - Ginny Selz (virginia.selz@noaa.gov)
NIDIS Program - Veva Deheza (veva.deheza@noaa.gov)
MAPP Program - Annarita Mariotti (annarita.mariotti@noaa.gov)
RISA Program - Chelsea Combest-Friedman (chelsea.combest-friedman@noaa.gov)
Assessment Program - Dan Barrie (daniel.barrie@noaa.gov)
NCEI Technical Support Unit - David Easterling (david.easterling@noaa.gov)

Additional General Guidelines for Applicants

- Principal Investigators submitting a proposal in response to this Announcement are required to follow the Letters of Intent (LOI) and Proposal preparation and submission guidelines described in the Climate Program Office FY 2020 Federal Funding Opportunity announcement.
- Investigators are strongly encouraged to submit an LOI prior to developing and submitting a full proposal using the FY20 Letter of Intent submission form[12]; investigators unable to submit via the form should email their LOI to daniel.barrie@noaa.gov. Investigators will be notified by the Competition Manager as to whether a full proposal is encouraged based on the LOI within 30 days of the LOI due date.
- Administrative questions regarding the Federal Funding Opportunity (e.g. proposal formatting or submission guidelines) should be directed to Diane Brown (diane.brown@noaa.gov).

Data Archiving and Computational Resources

Computational Resources

Computational resources on NOAA's high-performance computing platforms may be requested for research sponsored as a result of this solicitation. Proposals should indicate the availability of alternative computing resources should NOAA resources not be available for the project. Proposers who choose to request computational allocations on NOAA's platforms must include in their proposal a request describing the computational resources and data storage required, as well as a description of how they will port their methodology to the NOAA platforms. Proposers must submit an HPC Request Form with their proposal in order to apply for computational resources[13].

[11] https://cordis.europa.eu/project/rcn/188836/reporting/en
[12] Note, a Google account is needed to submit via this LOI submission form: https://forms.gle/zKEyp47w6xbe5F7f6
[13] HPC Request Form

Questions regarding the use of NOAA's high-performance computing platforms should be directed to Dan Barrie (daniel.barrie@noaa.gov).

Data Management Guidance

We require that all products and deliverables produced via solicitation will reside in the open access / open source domain, freely available to the public.

Public access to grant/contract-produced data will be enabled in one of the following ways (select one):

- Funding recipients are planning to submit data to NOAA National Centers for Environmental Information (NCEI), which will provide public access and archiving[14]. Point of Contact for NCEI is Nancy Ritchey (Nancy.Ritchey@noaa.gov)
- Data are to be submitted to the International Council for Science (ICSU) World Data System facility: https://www.icsu-wds.org/community/membership/regular-members)
- An existing publicly accessible online data server at the funded institution is to be used to host these data (describe in proposal).
- An existing publicly accessible online "cloud" service is to be used to host the data (described in the proposal).

The Competition Manager (above) is the responsible NOAA Official for questions regarding this guidance and for verifying accessibility of data produced by funding recipients.

[14] NCEI supports the creation of adequate metadata and data ingest into long term repository holdings using tools such as Send2NCEI (www.nodc.noaa.gov/s2n), for small volume, one-time only data collections) and Advanced Tracking and Resource tool for Archive Collections or ATRAC (www.ncdc.noaa.gov/atrac), for recurring and/or large volume data collections).